Interface, ergotic

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This term qualifies an interface that makes it possible to simulate an ergotic interaction between the man and something in the computer.

One can relate it with more usual expressions and terms such as responsive input devices [Cadoz et al., 1988], force-feedback gestural transducer [Luciani et al., 1994], haptic interface, force-feedback device, etc – [→ Haptics, haptic devices] – haptic device. All these terms and expressions are easy to use but they don't express scientifically, with a sufficient precision to avoid misunderstanding, the content of the concept and consequently of the underlying technological principles. It is then of an actual relevance to have this specific term in order to avoid some frequent confusions.

Let us first recall the definition of the ergotic [Cadoz, 1994] [Cadoz, 2000] [Luciani et al., 2004] function of the gestural channel [→ Gestural channel] [Cadoz, 1994] [Cadoz, 2000].

We consider that the relations of the human to his human or material environment are, simultaneously or separately, of three possible types:

- Epistemic

  When he gets some knowledge from it.
- Semiotic

  When he produces, by a means or by another, with or without a material intermediary, something which can potentially or actually emit an information, bear a message, a knowledge, etc. addressed to other human beings.
- Ergotic

  When, physically engaged (by his hands, his arms, his legs, his whole body) he enters in a mechanical interaction with a material object or a material part of the environment. In this case, there is a mechanical work spent not only in the human body, but, globally, in the complete mechanical system constituted of the human and of the manipulated physical object. The consequence is a mechanical modification or transformation of the object or of the material environment or, at least locomotion of the human being. The human being is then the source of energy producing this mechanical work.

It is important to notice several essential points:

- These three functions are not exclusive.
- Only the gestural channel can play the ergotic function (not the acoustical or visual ones).
- The gestural channel can support all the three: epistemic, when, for example, touching and manipulating physical objects, we get knowledge on their surface quality, forms, weight, temperatures, etc., semiotic, when, for example, we do some sign of the hand or play a musical instrument, and ergotic when for example we insert a nail with a hammer.
- Furthermore, the gestural channel can play the three functions at the same time and, in certain cases, the ergotic aspect is necessary so that the epistemic and/or the semiotic functions can be effective. A typical example is the instrumental gesture with a musical instrument, for example a violin where the violinist needs to physically interact, through the bow, with the string, in order to feel everything in his fingers if he wants to success in the expressivity of his gesture and of the sound produced.
- But of course, the ergotic function can be played without any semiotic or epistemic role.
- And finally, semiotic and epistemic functions can be supported by other channels than gestural channel.

So, when the human is in relation with the computer or with the human or material environment through the computer, it is of course impossible to speak about ergotic relation with the computer itself, unless we consider for example the actions to transport or to break it.

However, when we implement and use force-feedback devices within a computer, we actually bring into play the ergotic function of the gestural channel. Indeed we enter in a mechanical interaction with a material object (the stick, the keys, the levers, etc. of the device). Manipulating it and playing with - or opposing to - certain of its movements, we are producing mechanical work, exchanging, and, globally, spending energy.

This is this paradoxical situation that we must clear up.

Two kinds of combined considerations will enable us to do it:

- The first giving a clear characterization of the constitutive functionalities of such interfaces.
- The second trying to answer the question with what are we interacting? in such situations.

Constitutive functionalities of an ergotic interface

From one side, we have a mechanical real part (the material part we are actually manipulating), one the other digital data and digital processing.

We don't interact with digital data or processing, in the previous physical sense. The digital data and processing of course correspond to energy spending and exchanging, but i) at a scale which is not commensurable with the gestural energy, and ii) without any obvious quantitative correspondence like it may exist between the gesture energy of a violinist and the acoustical energy he produces when playing.

Digital data and processing are, from a purely energy point of view, mainly electronic or magnetic phenomena.

So, between the two extremities of the complete device, there are at least transducers, for example, transducers converting mechanical energy into electrical one or conversely.

As we can know, a transducer is generally with single direction: a displacement or a force sensor can convert displacement or force phenomena into electrical phenomena. But the opposite transducers are generally built with another technological principle.

This implies that if we want to assume the inherent symmetry of the ergotic interaction, we need at least two combined kinds of transducers, a first one taking in charge the man to computer direction, and a second one assuming the computer to man direction.

The first category may be displacement sensor, force sensor, etc. The second one is no more no less than what we call a motor, an electro-mechanical motor.

Now, the digital data, whereas they are indeed electric (or electronic, etc.), are binary numerical representations of the direct electrical phenomena received or sent to the transducers. The digital to analog converters and analog to digital converters are well known since the middle of the 50's. In fact, the importance of digital nature of phenomena is, as everyone knows, that it allows the symbolic processing, within the computational technology.

But what is more important is the difference in scale of energies concerned.

If it is possible, from the man to the digital data universe, to consider that the energy in the second one is very little, compared to the previous, and, consequently that (although it is not at all the case) it could be extracted from this one, it is absolutely impossible in the opposite direction. The energy corresponding to what it must be opposed to the human gesture, by a motor, must be provided by a supplementary external source.

This is a first unconditional necessity within an ergotic interface. In a certain way, we can say that the thing with what the human is interacting (of course in a very spe-

cific way) is this external energy source transduced with a motor.

A second important point, indissociable of this concept of ergotic interface, is the notion of amplification or (close concept) of energy relay.

Indeed, when we drive the input current of a motor in order to make the electromotive force provided by it corresponding to a certain value, represented by a certain value of a low energy signal, we use such a relay of energy: There are two different energy sources and two different energy circuits (the primary or control one, and the secondary one) of completely different scales and with a very specific influence between the first and the second: a small variation in the first can, for example, imply a strong (but analog) one in the second.

Although the principle of the energy relay probably gone up with Alexandrians engineers (300 before JC), it is, of course the three-electrodes lamp, then the transistor, from the twentieth century, which are the essential representatives of this principle.

So, as a consequence, we can say that the energy continuum is here broken (which is not the case when, for example, we play a musical instrument).

With what are we interacting?

As said below, rigorously speaking, we are interacting with an electrical energy source transduced by an electro-mechanical motor. But we know also that it is not so simple, since the amplifier, with its input and output phenomena, is playing a strong role.

We know that, in the usual uses, the sensors and analog to digital converters of the enactive interface provide input data to the computer, which processes something and returns digital data to the digital to analog converters.

Very roughly speaking, we can consider two different situations:

- One where the data, as well in input as in output are, and remain symbols or abstraction, like for example when we use a force-feedback device in order to follow the shape of a mathematical curve – in this case, incidentally, it is legitimate to speak of haptic rendering [→ Haptic rendering of virtual objects].
- One where, expressly, the input and output events, as well as the internal data processing are specifically conceived in order to establish a believable correspondence with possible real physical objects. In this case, we will speak of simulation, of course.

Let's just add that in the previous case, even with very formal or abstract data, it is often possible (by an enactive feature) to give a believable physical interpretation of the process (the "thing") inside the computer.

But, to conclude:

Even when the digital process is a very genuine simulation of a physical realistic object, it is not correct to say that we have an ergotic interaction with this object.

The correct attitude is to say that we simulate the ergotic interaction with a simulated object, (while, strictly speaking, we are interacting with an electric energy source).

Having guaranteed the conditions for such a simulation of an interaction with a simulated object, it is possible now, according to the various situations and our various goals, to add or not the simulation of semiotic and/or epistemic relation within the gestural channel, even in a multisensory context, around our ergotic interface which can become the core of any other haptic, force-feedback, multimodal, etc. and, of course… enactive interfaces.

References

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